

Issue #03 April 2016

Amsterdam Science

**Loop
models**

**Lynda Hardman:
women in science**

**Plant
defence**

A magazine with a mission...

Amsterdam Science magazine does not only have a mission to communicate scientific achievements, but also to address important issues in society. The under-representation of women in leading positions in science is an issue that we feel deserves more attention in the Amsterdam science community. In this issue's interview with Lynda Hardman the theme of 'Women in Science' is analysed and discussed. Clearly, we are far from having gender balance in leading science positions. Although affirmative action will strengthen the position of women, Lynda rightfully challenges us all: "as long as the managers and senior academics themselves do not realise that they are part of the problem, you are not going to get the change that is so desperately needed." Her recommendation that at least 30% of positions in committees, conference line-ups and outreach programmes should be taken by women gives our community a tangible goal. For our part, our magazine strives to have an equal representation of both genders, both in terms of the contributing authors, as well as in the editorial board.

The content of this issue covers a broad range of topics: spanning from a 'first' for Amsterdam Science in terms of carrying a contribution from the social sciences, to an intriguing mathematics contribution on loop models. We are happy to see that the broadening base of our editorial board is reflected in a broader scope of coverage of science in and around Amsterdam. Given their key role in this and issues to come, we extend a welcome to our new members of the editorial board: Ted, Mohit, Mustafa, Joen, Namrata, Lucyna and Esther. They represent the Netherlands Institute of Neuroscience, the VU Medical Centre, the Science Faculties of the VU University Amsterdam as well as the University of Amsterdam, and have also been instrumental in updating the website and introducing a sharper focus to our presence in social media [try a visit to our Facebook page!].

This issue's infographic takes you on a journey to the cosmic clock of a triple star system: a recent discovery that allows scientist to investigate Einstein's theory on general relativity in more detail. The clocks in The Hague do not always tick in time with the natural rhythm of science, and our columnist Renée van Amerongen shares her frustration on behalf of many scientists on the almost Kafka-esque side effects of new employment for the Dutch science system, under which it is becoming virtually impossible to run a lab and ensure continuity in research at the same time.

We are visual animals and the artistic value of scientific images is clearly illustrated by both the cover images and the centrefold. More scientific images 'made in Amsterdam' can also be found on the website of the New Realism project: <http://newrealism.org/>.

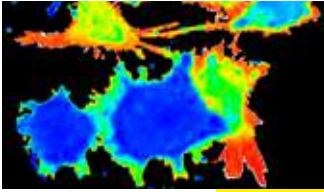
We close by burdening you with the easy task of enjoying a tremendous third issue and don't forget to visit the website to submit your own Amsterdam Science contribution for edition four!

On behalf of the Editors-in-Chief,
Michel Haring

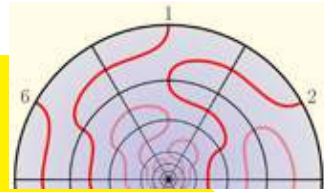
ABOUT THE COVER IMAGE:

The Biosolar Cells consortium develops technologies to produce fuels with solar energy. Of its extensive research programme, one project focuses on biodiesel production with the algae *Botryococcus braunii* (see cover image). Living in colonies, this algae is known for producing large amounts of oil, giving it advantages over other algae. At the same time, the presence of oil complicates the interaction with light and nutrients in a photobioreactor. In addition, recent studies show that symbiotic interactions with bacteria provide yet another parameter to be optimised for biofuel production.

Image credit: Tom van den Berg, PhD candidate Biophysics of Photosynthesis, VU University



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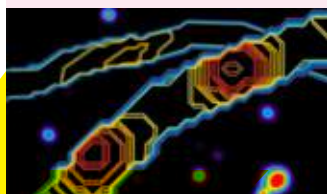
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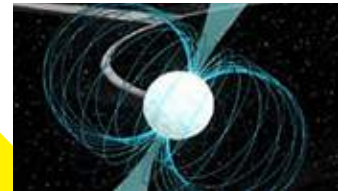
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Caught in the act: dynamic regulation of cell shape



© JOACHIM GOEDHART is assistant professor in the Molecular Cytology section at the Swammerdam Institute for Life Sciences of the UvA.

→ Cells show remarkable differences in shape and size: a nerve cell is elongated, a liver cell has a compact, cube-like appearance. The shape of a cell can alter dramatically during its lifetime, with cell migration or cell division being good examples. Cell structure is determined by a sturdy yet flexible intracellular framework known as the cytoskeleton. It is composed of large protein-polymer networks that can be remodelled by RhoGTPases, a family of signalling proteins that behave as molecular switches. Live-cell imaging and novel fluorescent probes provide a unique real-time window on cellular shape changes and the molecules involved.

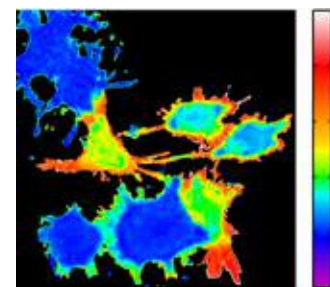
PhD student Jakobus van Unen and colleagues recently described novel imaging tools to activate and measure RhoGTPases with high precision and sensitivity. They showed that specific activation of RhoGTPases near the surface of a cell induced actin polymerization, a hallmark of cytoskeletal

remodelling. This activity is powerful enough to turn a neuron-like, elongated cell into a spherically shaped cell.

The importance of local and specific RhoGTPase activation was shown in a second study, in collaboration with Sanquin. To fight inflammation in the body, white blood cells need to be able to leave the blood vessels, passing through the endothelial cell layer that lines these vessels. Using the newly developed imaging tools, it could be shown that white blood cells induce RhoGTPase activity in a very local manner in the endothelial cells they need to get through. A ring of RhoGTPase activity is seen to surround the white blood cells, inducing local actin polymerization, enabling the gap between the white blood cell and the endothelial cells to be sealed rapidly, preventing leakage. Taken together, these studies show how the new imaging technique has enabled us to home in on the importance of spatially controlled RhoGTPase activity. Ω

→ Reference

1. J. van Unen et al., *Scientific Reports* 5, 14693 (2015) www.nature.com/articles/srep14693
2. H. Heemskerk et al., *Nature Communications* 7, 10493 (2016) <http://dx.doi.org/10.1038/ncomms10493>



↑ Figure

A novel cellular imaging technique reveals high RhoGTPase activity at the periphery instead of in the centre of the cell, indicated in the image by false colour coding: red [blue] designates high [low] activity.

Nano 'pompom beanies': seriously playful chemistry



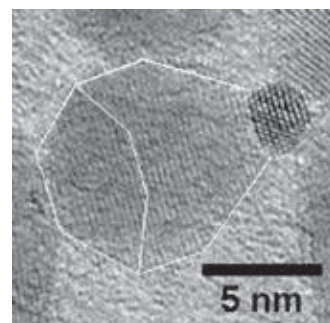
ALINA CHANAWEA is a postdoctoral researcher at the Department of Physics and Astronomy, Physics of Energy group, VU University Amsterdam

→ Nanotechnology: the concepts of miniature machines that travel through the human body and repair damaged tissues, or supercomputers small enough to fit in a pocket, still feel like science fiction. After all, the knowledge we gained in the past 30 years - this is how old the field actually is - opens up almost unlimited applications.

Nanostructured materials were shown to have potential as low-threshold lasers, optical filters, solar energy converters, biosensors and chemical catalysts, among other applications. Nanostructures are especially attractive as catalysts, since their surface area is large compared to their volume. This means that less material is needed to do the same job of, for example, splitting water to generate hydrogen as an energy carrier. To make the process even more efficient, the catalyst, a semiconductor, should be combined with a metal helping to shuttle charges from the catalyst to the water and vice versa. This is exactly what we have done. Advanced chemical techniques enabled us to build complex hybrid nanostructures starting from atoms. By using the twist of making a ZnO 'beanie' we were able to grow a gold 'pompom' on the very tip of it. A

nanoscale 'pompom beanie' (or a nano version of what the brits call a bobble-hat) is shown in the Figure and demonstrates the creativity and playfulness of functional design at the nanometre scale. We performed optical characterization of the nanostructures, together with electrochemical measurements in solution confirming the charge redistribution within the hybrid structure, which is key to improving the function of the hybrid catalyst.

In future work, we will test the use of our nano 'pompom beanie' catalyst for water splitting by measuring the amount of hydrogen produced. Besides catalysis, the strategy of deliberately juxtaposing different combinations of nanomaterials is promising for nanoelectronics, optics, sensors etc. Who knows, one day it might still lead to development of a nanorobot... Ω



↑ Figure

Transmission electron micrograph of a zinc oxide 'beanie' with a gold 'pompom' on the very tip.

→ Reference

- A. Chanaewa, J. Schmitt, M. Meyns, M. Volkmann, C. Klinke, E. von Hauff, J. Phys. Chem. C 119 (37), 21704–21710 (2015) <http://pubs.acs.org/doi/abs/10.1021/acs.jpcc.5b06520>

Salt crystals: destroyers of artworks & monuments



NOUSHINE SHAHIDZADEH is associate professor at the Van der Waals-Zeeman Institute, Institute of Physics, UvA.

→ **Artworks such as sculptures, historical monuments, frescos and paintings are all subject to physical and chemical changes over time. A major problem, particularly in the conservation of our cultural heritage, is their deterioration due to the action of salts.**

An innocent pinch of salt may add flavour to our Dutch *patat*, but those same salt crystals have led to the partial destruction of unique, ancient buildings such as those in the Valley of the Kings in Egypt or the Petra monument in Jordan. Most monuments are made of porous stones, and the pore network can contain both salts and water. These salts can be derived from external sources, for example from ground water contaminated with de-icing salt used on roads, or they can be naturally present in the materials used for construction. Depending on climate variables such as temperature and humidity, the salts may crystallise either in the form of efflorescence (on the surface of the stone) or subflorescence (within the pore network). In the latter case, damage occurs if the crystal continues to grow in the pore, thereby causing stresses that can lead to granular disintegration, flaking of the surface layers and micro-cracks.

Although salt crystallisation in stone artworks has been studied extensively over the past few decades, it is still incompletely understood. The precise mechanisms and kinetics of crystal growth under confined conditions, starting from small volumes of salt solutions, remain challenging topics. According to crystal growth theories, a mechanically constrained crystal should dissolve rather than exert a pressure, or it could simply grow in the direction of the opening of the pore, thus relieving the pressure. The fact that crystal-induced mechanical stresses nonetheless occur in practice leads to lively discussions as to their microscopic origins.

We have studied the spontaneous nucleation and growth of sodium chloride, the most abundant salt on earth, induced by evaporation of a small volume of salt solution. Under lab conditions, the pore is represented by microcapillaries or by the gap between two confining plates entrapping the salt solution. In a specially designed and purpose-built set-up, we are capable of measuring the mechanical stress caused by the growth of the crystal in confinement during evaporation. Our results show that the precipitation of sodium chloride crystals, independent of the size, shape and surface properties of the microcapillary, happens at a salt concentration (10 molal) that is much higher than the saturation concentration of the salt (6.14 molal).

“Salt crystals growing inside porous stone can exert pressure.”

Here, classical nucleation theory provides an explanation in that the concentration of ~10 molal corresponds to the metastability limit at which nucleation first becomes observable on experimental time scales: the nucleation rate is extremely small below and very large above this concentration. A consequence of this high supersaturation is that instead of the usual cubic salt crystals, we observe the very rapid growth of skeletal or ‘hopper’ crystals that form due to the difference between crystal growth rates on the crystal edges and on the crystal faces. The formation of such hopper crystals requires a two-dimensional (Kossel-Stranski-Volmer) growth, involving the creation of two-dimensional ‘islands’ of molecules that subsequently spread outward. This mechanism favours edge growth over growth from the centre of the crystal faces, resulting in a hollow crystal (see Figure). Such a rapid growth of the critical nucleus will lead to a very rapid decrease of the local supersaturation. Consequently, as the nucleation rate depends very sensitively on the salt concentration, in small confined volumes a single skeletal crystal nucleus forms instead of the several nuclei that would be expected from the high level of supersaturation.

Parallel experiments done in real sandstone indeed reveal the formation of hopper crystals in the pores of the stone, proving that sodium chloride can easily reach supersaturation levels far higher than what is commonly assumed for this salt. Moreover, we found that the pressure exerted by the growth of the crystal in pore-sized confinement is very high. Our results suggest that the pressure originates from a repulsive interaction between charged surfaces separated by the liquid film of solution. The measured pressure is in excess of the tensile strength of some types of stones used in artworks and monuments, thus providing evidence that salt crystallisation is indeed an important cause of damage in these porous materials. Ω

↓ **Figure 1**

An example of a historical sandstone sculpture suffering from degradation (picture taken in Lecce, Italy by N. Shahidzadeh).



↓ **Figure 2**

Electron microscopy picture of a sodium chloride crystal. Skeletal or ‘hopper’ crystals have a hollow shape as growth at the edges of the crystal is favoured over growth at the centre of the crystal faces.



→ Reference

J. Desarnaud, H. Derluyn, J. Carmeliet, D. Bonn, N. Shahidzadeh. Metastability limit for the nucleation of NaCl crystals in confinement. *J. Phys. Chem. Lett.* 5, 890-895 (2014). J. Desarnaud, H. Derluyn, L. Molari, S. de Miranda, V. Crundde, N. Shahidzadeh. Drying of salt contaminated porous media; Effect of primary and secondary nucleation. *J. App. Phys.* 118, 114901 (2015).



An interview with Lynda Hardman of Centrum
Wiskunde & Informatica (CWI).

Promoting women in science

By HAMIDEH AFSARMANESH, Professor
of Computer Science, UvA, and
NOUSHINE SHAHIDZADEH, Associate
Professor of Physics, UvA.

→ We visited Lynda Hardman at her office at CWI in the Science Park. As soon as we arrived, she gave us both a copy of the January 2016 issue of the magazine of the European Research Consortium for Informatics. It contains a section about the European working group 'Women in ICT Research and Education', which she coordinated.

Next to being recognised for your own research in computer science, what motivated you to also invest time in promoting the participation of women in informatics research?

"When I was in Edinburgh working in the Artificial Intelligence department in my early twenties, only few girls were choosing to study the subject - which I thought

was a shame, since it's such an interesting topic. So I became involved in extracurricular activities for girls at schools. Later on in the 1990s, when I was at CWI in Amsterdam - first as a researcher, then working towards my PhD and later on as a group leader - I noticed again that there were so few women around, but this was not a subject that you talked about. In 2009, when I became a professor by special appointment at the University of Amsterdam, they recommended I take the introductory course for new professors, which was led by a female instructor, who was clearly very aware of the gender gap in academia in the Netherlands. She didn't push me to get active in this area, but through her I came to understand that the gender issue is much more

"Girls need female role models comfortable with science in order to encourage them at a young age in schools."

of a problem than I had previously realised, and so I went from being an 'example' of women in computer science to an activist, wishing to bring about change."

According to the '*She figures 2012*', which is the statistical study carried out by the European commission, women are under-represented in both public and private research sectors by a factor of 3, and even by a factor of 5 when the business sectors are considered. What do you think can be the main reasons for this?

"To uncover the real reasons, we need to turn to social science studies. However, in my opinion, there are no physical or hormonal reasons that women like working in research or business less than →

LYNDA HARDMAN

(<http://www.cwi.nl/~lynda/>) is a member of the management team at CWI (Centrum Wiskunde & Informatica) and Professor of Multimedia Discourse Interaction at Utrecht University. She graduated in Mathematics and Physics from Glasgow University in 1982. During several years in the software industry she was the development manager for Guide - the first hypertext authoring system for personal computers (1986). Her PhD thesis (UvA, 1998), on combining time-dependent documents (such as video sequences) along with interaction through links into a single model, contributed significantly to the first World Wide Web Consortium Synchronized Multimedia Integration Language (SMIL) recommendation. Since the development of the semantic web, Lynda has investigated improving human information access in applications using the rapidly expanding 'linked open data cloud' for creating linked-data driven, user-centric applications for exploring media content. Specifically, she is interested in using existing domain models in media annotations to enhance information exploration and in developing computational models of human communication to assist in this. Additionally, she is interested in developing design methods for human-based interfaces for emerging technologies, where technological innovation goes hand in hand with understanding underlying user requirements. In 2014, Lynda was named a Distinguished Scientist by the Association for Computing Machinery (<http://acm.org>). She is president of Informatics Europe (<http://www.informatics-europe.org/>), whose mission is to foster the development of quality research and teaching in informatics.

men do. The reasons are more cultural, causing a mix of internal and external barriers for women. From my understanding, the cultural tradition - mainly in the Netherlands but also in other parts of Europe - contains the stereotype that women are interested in arts and men in sciences. Gender bias starts early: at least in the Netherlands, girls tend to be less interested in technical and mathematical topics already at primary school. This is also not helped by the trend that primary school teachers have been trained for the more social aspects of their job and often have less affinity with technical sciences. Girls need female role models comfortable with science in order to encourage them at a young age in schools."

"One problem is certainly related to the psychology difference between girls and boys. As an example: when high-school girls get 6 out of 10 for a test, they think they are not good at the topic, whereas boys take a 6 as a sign that they are good at that subject. This leads to a lack of confidence in girls in their own talents for science and technology subjects, and prevents them from continuing in science. Organising special workshops for high-school students at universities may help. Researchers can explain their research activities and encourage boys and girls to work as scientists. We need to bear in mind that even if *all* the speakers at such an event were women, the boys would still choose to do science if the subject is interesting, the reverse is not true if the list of speakers is a men-only affair."

"To try and generate and maintain more grass-roots female interest in science, technology, engineering and mathematics, VHTO (<http://www.vhto.nl/>) - the Dutch national expert organisation on women and science and technology, puts a lot of effort into organizing 'Girls' Days' in different parts of the country. For instance, a friend of mine working at TomTom is involved in this programme, explaining to high-school girls that they can learn how to design and build navigation systems, or to manage a development project. Learning about how women are contributing to a familiar product such as TomTom makes it much easier for them to picture their own possible future in the tech sector."

"If the teachers are not able to supply this role model, then parents

can get involved in sharing their knowledge and interest in science with the girls. At my children's primary school we used 'Rekentiger' (Arithmetic tiger) for the few kids who liked maths. I came along once a week for half an hour to answer their questions and make sure they worked. My daughter did not like it much, since I was her mum, but the other students were happy to sit outside the class and deal with the challenges. I think it worked well, although one student quit since he was the only boy within a group of four girls."

When focusing on the Netherlands, most statistics show that there are fewer women in senior science positions than in many other European countries. Which organisations need to take action and get involved?

"At the level of universities, our Minister of Education is stressing that the current situation is unacceptable and is encouraging universities to come up with solutions. LNVH (<http://www.lnvh.nl/>), the Dutch national network for female professors, visits every Dutch university board once a year to discuss the relative numbers of female lecturers and professors and what they intend to do about increasing specific instances of under-representation. I have been involved in some of these meetings at the University of Amsterdam. The Board of the UvA is very keen to increase the proportion of women in senior positions, but explains that specific measures have to be taken at the faculty level. One of the recommendations by LNVH is to have more open and transparent tenure-track systems, so that 'closed-shop' internal promotions (more often of men) to permanent positions are avoided. Women-only tenure-track programmes allow the attraction and retention of excellent female faculty, and the tenure decision is based upon a set of pre-determined criteria within a period of 4 or 5 years. We have to help all our colleagues be aware that they need to promote women so that it becomes normal that women can be scientists. To give an example, when organising conferences, at least 30% of keynote speakers being invited should be from the under-represented gender, be that female or male. If this is not the case, then programme committee members should flag this with the main organisers."

"As long as the managers and senior academics themselves do not realise that they are part of the problem, you are not going to get the change that is so desperately needed."



© L. Dingemans

As the current president of Informatics Europe (IE, <http://www.informatics-europe.org/>), and the founding chair of the Women in ICT Research and Education working group (IE-WIRE), how do you see the role that can be played by such international associations in promoting women in the field?

“These organisations are very aware of the shortage of women in informatics and computer science. IE gives guidance for heads of departments, whereas the Association for Computing Machinery (ACM) is more oriented to individual members. IE-WIRE has produced a booklet to raise awareness of concrete best practices that departments can carry out. IE-WIRE is launching an award this year for departments that can demonstrate that best practices can really make a difference. ACM Women Europe (<http://europe.acm.org/acm-w-europe.html>) organises events for younger professional women, at BSc, MSc and PhD levels, to help them form a support network and allow them to discuss issues together. Companies such as Google, Bloomberg, Microsoft and Intel sponsor these events not just out of charity but because they see a more balanced workforce as an important factor contributing to their profit margins.”

Turning back to the Netherlands, the proportion of women in Dutch academic positions drops significantly at each consecutive career stage from PhD through to professorial appointments (see Figure). What needs to be changed? Should the same criteria be applied for evaluating women with young children as for other applicants?

“We must find solutions to deal with the critical periods in both women’s and men’s lives. The best approach is to ask mothers and fathers themselves what they need, which may be arrangements facilitating their time away from work or a gradual instead of sudden return to full-time work. Of course there are simple and logical measures organisations can take to make themselves mother-friendlier, for example providing breast-feeding facilities on site, and planning meetings between 9:30 and 16:30. Also supporting the extra costs that scientists would make - for instance for travelling to conferences - when they have an infant during the breast-feeding period. Furthermore, granting organisations such as NWO and ERC must be prepared to spend extra money to extend PhD and postdoc contracts for those who have just become parents. We need to be aware of how parenthood plays a role in researchers’ lives, where this is often more of

a burden for mothers than for fathers. For instance, NWO and ERC add 18 months onto the mother’s PhD date when assessing her CV. This is an effective way of compensating time for motherhood. We just need to make sure that selection committees really take this into account when they assess candidates. This is very important when you compare candidates for a given position, for example when counting their publications and citations. A more controversial idea is to reward a group when they hire a female scientist, for example, by providing some financial bonus for travel, equipment or extra support staff. This creates an incentive to search outside the (probably) male network in order to hire a competitive female staff member.”

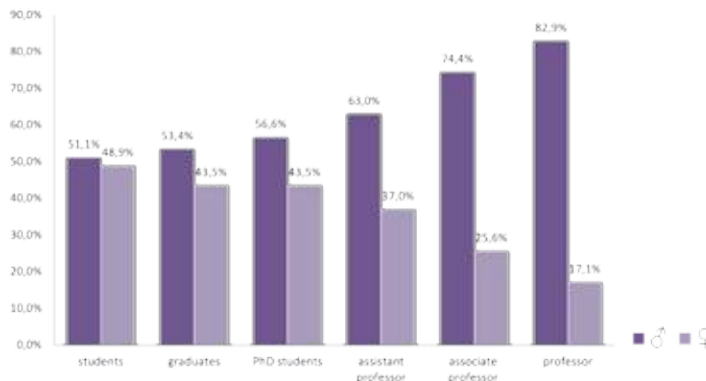
“At the same time, female candidates do have to be excellent: quality should play a more important role than quantity. It is also important to provide coaching and mentoring for women, to encourage them to apply for higher positions, to challenge them to prepare for promotions, and broadcast their achievements rather than shying away from the competition.”

Do you think that applying quota in academia would be appropriate or the introduction of affirmative action, in order to help resolve career constraints faced by women?

“A quorum should be used only as a last resort. It can perhaps help in a start-up phase but it is important to distinguish between defining a goal and imposing quota. If you impose quota, you may attract candidates who are not necessarily qualified. Moreover, the women who are hired as part of a quota system do not feel comfortable about it. Affirmative action is, however, very different. In the context of the Science Faculty here at the UvA, the MacGillavry fellowships are an example of an action that works very well as the positions have to be won under strong, international competition and are not based on quota. As a result, the MacGillavry fellows being hired are recognised as being excellent and internationally competitive, meaning no-one doubts that they deserved the positions they got.”

“So, for sure, affirmative actions should be put in place and enforced, but only in conjunction with ‘un- →

“Quota should be used as a last resort.”



← Figure

Gender distribution in Dutch academia, from student to professor.

Taken from the Monitor Women Professors 2015 by LNVH.

<http://www.lnvh.nl/site/LNVH-Publications/Monitor/Monitor-Vrouwelijke-Hoogleraren-2015>

conscious bias' training at the senior scientific and management levels. To put it bluntly, as long as the managers and senior academics themselves do not realise that they are part of the problem, you are not going to get the change that is so desperately needed."

Zooming back out beyond the specifics of the Dutch gender gap, do you think the new policies introduced by the European Commission for industry and research organisations, such as the

'Code of best practices for women and ICT' should be enforced and will be effective?

"In my opinion, having a code of best practice is a requirement but does not act as a guarantee of results. For instance, the Faculty of Science at the University of Amsterdam already has a code of best practices, which formally apply to hiring teaching and research staff. Apparently, however, the existence of this code has not helped increase the number of female faculty members. In all such cases, it is impera-

tive that the *local* management level really wants to change the situation. They can do so by applying the existing code of best practices. Until there are 30% of women at all levels, the culture will remain one that pushes out women – even though this may be wholly unintentional. The goal is in any case to ensure that women do not drop out at a higher rate than men. In the United Kingdom, the Athena SWAN Charter was established in 2005 to encourage and recognise commitment to advancing

the higher education and research careers of women in science, technology, engineering, mathematics and medicine. Awards are given to departments or institutes for activities related to gender balance. Initiatives such as this can play an important role at the national level, where higher levels of the award (e.g. bronze, silver, gold) may be considered as prestigious providers of a competitive edge for institutes applying for national grants. This is an example of an initiative we may want to copy in the Netherlands." Ω



JORIS MESSELINK performed this research as Master's student Theoretical Physics at the UvA/VU.

Traffic jams inside our cells

→ When navigating through a city, we become participants in an intricate, citywide transport network consisting of many roads merging, separating and intersecting, over which people and cargo are continually transported.

Transport inside your cells shows remarkable similarity to transport over an urban network. Instead of via roads, intracellular transport takes place via a network of microtubuli and actin filaments. And instead of cars and trucks, so-called molecular motors navigate the network, by walking across the filaments using two microscopic feet (see Figure), dragging cargo along with them.

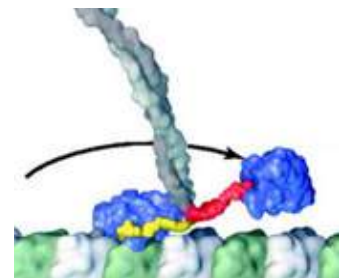
In urban traffic, we regularly encounter traffic jams, where a region in which cars can freely move makes an abrupt transition to a region in which all cars are stuck, and can't move. A similar effect has been observed for molecular motors in cells, for which a sudden transition between a free-flowing, low-density region and a traffic-jam-like high-density region can occur.

In my Master's project, I studied this kind of collective dynamics of molecular motors. To do so, I used what we call a minimal physical model for the system, which is expected to capture its essential features. This model is known as the 'totally asymmetric simple exclusion process' (TASEP) model, and it describes particles moving uni-directionally over a lattice while preventing each other from occupying the same space.

It was previously assumed that the average density of motors in a region provided sufficient information to predict the time needed to cross this region. However, I demonstrated that if the system is in a traffic-jam state, the movement of the boundary between density regions also has to be taken into account. The location of the boundary varies over time: sometimes almost the entire system is stuck in a jam, sometimes almost all molecular motors can move freely. By analytically describing this movement, accurate results for the crossing times were obtained.

→ Reference

J. Messelink, R. Rens, M. Vahabi, F.C. MacKintosh, A. Sharma. On-site residence time in a driven diffusive system: Violation and recovery of a mean-field description. *Physical Review E*, 93(1), 012119 [2016].
<http://journals.aps.org/pre/abstract/10.1103/PhysRevE.93.012119>



↑ Figure

Illustration of a molecular motor 'walking' across a cellular filament.

Settling the 'nature versus nurture' debate

©
TINCA POLDERMAN is Assistant
Professor in Complex Trait
Genetics at VU University
Amsterdam.



→ Ever since Sir Francis Galton suggested in 1869 that 'eminence' was heritable, numerous scientists have investigated the causes of individual differences for a wide variety of human traits. While these studies have sparked a lively 'nature versus nurture' debate in the past centuries, it was only since a few decades ago that the nature-nurture dispute has been the subject of serious investigation by means of genetic techniques. In genetics, 'nature' is commonly defined as heritability, which is the proportion of variation of a certain trait that is due to genetic variation. For example, a heritability of 80% for height means that 80% of the height differences among individuals in a population is due to the genetic differences between them. To disentangle genetic and environmental effects, data derived from relatives provides useful information, looking for instance at traits passed down in families versus those seen in adopted children. However, in the last few decades the real workhorses of heritability studies have been twins.

"Eye function is heritable for 71%, whereas social interactions weigh in at only 32%."

Why twins?

Monozygotic (MZ) twins are genetically identical, while dizygotic (DZ) twins, like all siblings, share on average 50% of their genes. Both types of twins, generally speaking, share their environment. By comparing the resemblance for a given trait in MZ twin pairs and in DZ twin pairs, we can obtain an estimate of genetic and environmental effects. When MZ twin pairs are - on average - more alike for a given trait than DZ pairs, one can assume that heritability plays a role in that trait. This conclusion about heritability is possible because the only difference between MZ and DZ twin pairs is the genetic similarity between the twins, while their environments are identical.

All traits are heritable!

We performed a meta-analysis on heritability estimates that were extracted from all twin studies published over the past 50 years. Working through 2,748 twin studies, we derived data on 17,804 traits, based on data from, in total, 14.5 million twin pairs. Most investigated traits were in the psychiatric, metabolic and cognitive domains, while far fewer studies focused on social and aging traits. Of note, virtually all studies were conducted in Western countries, making the African, South American and Asian continents largely under-represented.

Remarkably, all investigated traits were found to be heritable to some extent: not one trait had a heritability estimate of zero. The highest heritability estimates were for traits related to functions of the eye (71%), while one of the lowest heritability estimates was found for social values (32%). For some traits heritability differed across age groups. For example, cognitive abilities are highly heritable in adulthood, with almost no environmental influences, while in childhood the environmental influences are equally important as genetic effects. In other words, as people grow older, their cognitive abilities tend to grow closer to what their genes are 'encoding'

and, consequently, environment or upbringing becomes increasingly less important. Heritability estimates for males and females were amazingly similar across traits, so the contribution of genetic effects to trait variation is more or less the same in both sexes.

'Nature versus nurture' discussion closed?

When we performed the meta-analysis across all traits, ages and sexes, the contributions of genetic and environmental influences turned out to be equal. Thus, half of the overall variation we see in humans is due to genetic differences among individuals, while the other half is explained by differential exposures to environmental factors. While 'nurture' is often interpreted as parental monitoring, educational opportunities or peer influences, it actually includes many more effects. Environmental factors may occur during pregnancy or birth (for instance, exposure to nicotine, or birth complications), or may include exposure to pollution, food conditions, or specific neighbourhoods. Unfortunately, twin studies are limited in this sense: they only provide the relative contribution of genetic and environmental effects, and do not reveal the exact

causal factors, whether genetic or environmental. So, although this huge meta-analysis gives a robust basis for the 'nature versus nurture' debate, the identification of actual causal mechanisms remains open and represents an essential next step to better understand variation in human traits. For more information, all of the results of this study can be visualised using our web tool MATCH: <http://match.ctglab.nl>. Ω

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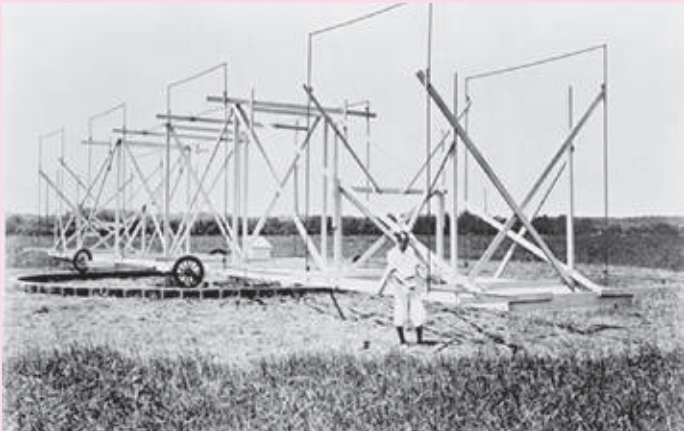
↓ Figure

Example of twin data available at website <http://match.ctglab.nl>. Interactive heritability (h) and shared environmental influences (c) estimates generated for two domains: Ophthalmological (eyes) and Social Interactions using the twin data.



Hundred years ago

Radio Astronomy — Primitive antennas connected to state-of-the-art computers



← **Figure 1**

The very first radio telescope, built by physicist Karl Jansky in the early 1930s. The telescope could be rotated in order to locate the source of the detected radio waves.

© NRAO/AUI/NSF

Sarah Brands, Master's student
Astronomy & Astrophysics, UvA

→ While people have looked at the sky since the dawn of mankind, the first cosmic radio waves were only detected in 1932. A radio wave is an electromagnetic wave with a wavelength in the range of 1 millimetre to 100 metres. In essence, it is very easy to detect: all you need is a simple antenna, like the one you find on top of old transistor radios. If a radio wave hits such an antenna, it will induce a small electric current, which can be amplified, registered and interpreted.

About a century ago, it was discovered that radio waves were rather suitable for telecommunication. In an attempt to improve transatlantic telephone services, Bell Telephone Laboratories gave physicist Karl Jansky the assignment to investigate interfering sources of radio waves. For this task Jansky built the very first radio telescope (Fig. 1). After a year of research Jansky concluded that, apart from radiation associated with thunderstorms, there was also a cosmic source of radio waves in the centre of the Milky Way. The first astronomical radio observation was a fact.

The discovery of Jansky fuelled the curiosity of an American radio operator and engineer called Grote Reber. Where exactly was

this radiation coming from, and how was it produced? Did other celestial objects also emit in radio frequencies? The economic depression meant that Bell Laboratories declined to hire him, so Reber decided to build a radio telescope in his own back yard. Persisting after several failed attempts, in 1937 Reber finally succeeded in making a map of the Milky Way in radio waves.

In the 1940s Martin Ryle was the first to connect multiple antennas in such a way that the individual signals could be combined into one collective signal. These interlinked antennas are collectively called an aperture array. The main advantage of this type of telescope is the high spatial resolution that can be obtained as the array acts like a telescope with a diameter equal to the largest separation between two antennas. As with an optical telescope, the larger the diameter of the telescope, the more details can be seen.

Nowadays, aperture arrays are still widely used. However, the instruments have been scaled up significantly: while the array of Ryle consisted of only two elements, LOFAR, currently the largest aperture array worldwide, consists of about 7000 antennas (Fig. 2). For each observation, the signals collected by each of these antennas have to be compared to the signals of the other antennas. With 7000 connected antennas, this means

that a large number of comparisons has to be made each time the telescope looks at the sky, something that LOFAR can do up to 195 times per second. All these calculations require massive computing power, and result in an enormous flood of data, which can run up to as much as several gigabytes of data every second. All these data are transported through an extensive network of supercomputers connected by glass fibre cables so as to store and process the collected data.

Astronomers at the UvA were closely involved in the design of LOFAR and use the telescope on

↓ **Figure 2**

The core of LOFAR is located in the Dutch province of Drenthe, but stations all over Europe are being built to be connected to the centre in the Netherlands.



© Top-Foto, Assen

a regular basis. The radio astronomy group in Amsterdam uses it primarily for pulsar research: these very compact, rapidly rotating stars can be regarded as cosmic clocks, and can teach us about fundamental physics in very extreme conditions (see for example the infographic on page 20 of this issue).

LOFAR is big, but even larger telescopes would allow us to see even more details. So why not be really ambitious and build a telescope that spans the entire Earth? Interlinking antennas located all over the world and even further separated in space might make it possible to directly observe the outer edges of black holes. This would be an extremely challenging project, because the relative position and time signals of all antennas have to be known very precisely in order to enable reconstruction of all the signals pouring in from such a large area. Computational power is another major challenge: the calculations needed even exceed the capabilities of present-day computers. Teams from all over the world are currently working on meeting these computational requirements. So while the receivers themselves - the heart of the most modern radio telescopes - still strongly resemble the primitive antennas used in the past, the computer technology needed to analyse all the incoming signals still lies in the future. Ω



CHRISTIAN LOHMANN leads the Synapse and Network Development group at the Netherlands Institute for Neuroscience.



JOHAN WINNUBST recently finished his PhD in the Synapse and Network Development group, Netherlands Institute for Neuroscience.

Poorly-connected synapses get depressed

→ Our brains are ready to interact with our environment from the moment we are born. For example, babies can see immediately after birth and recognise faces soon thereafter. The young brain can perceive and make sense of the environment without any prior experience, because neuronal connections are already laid out, refined and ready to receive the first information from the outside world. Developing neuronal circuits generate spontaneous activity, which in turn also helps to refine neuronal connectivity. In the past, we discovered that synaptic connections become refined with subcellular specificity in developing mice and rats, such that neighbouring synapses are frequently co-active and thus receive similar

input patterns. We also found that this synaptic clustering requires spontaneous neuronal activity to develop.

Recently we explored the synaptic plasticity mechanisms that help to establish synaptic clustering. We monitored naturally occurring changes in spontaneous activity of individual synapses using simultaneous whole-cell patch-clamp recordings and calcium imaging in the mouse visual cortex *in vivo*. Analysis of the activity changes across large populations of synapses uncovered a simple and efficient local plasticity rule: synapses that exhibit low synchronicity with nearby neighbours (those closer than 12 μm) become depressed in their transmission frequency. To test whether synaptic depression is indeed caused by out-of-sync activity, we experimentally desynchronized neuronal activity *in vitro* with single synapse precision, which – as expected – triggered synaptic depression. Our results reveal that spontaneous activity wires the developing nervous system much more precisely than previously thought. Ω



↑ Figure

An artistic rendering of clustered synaptic inputs featured on the cover of the *Neuron* journal (July 2015).

→ Reference

J. Winnubst, J.E. Cheyne, D. Niculescu, C. Lohmann. Spontaneous Activity Drives Local Synaptic Plasticity *In Vivo*. *Neuron* 87, 399–410 (2015).

See also

V. Kehayas, A. Holtmaat. Dissonant Synapses Shall Be Punished. *Neuron* 87, 245–247 (2015).

The Tired Hero: A qualitative study of the social meaning of burn-out in the Netherlands



JOLANDA J. BOERSMA has graduated as Msc in Medical Anthropology and Sociology at the UvA.

→ Symptoms associated with burn-out affect nearly one million Dutch employees, yet clinical diagnoses of burnout remain problematic. There is diagnostic uncertainty due to a lack of positive neurobiological biomarkers and evidence for specific biomedical mechanisms, meaning that burnout is solely verifiable based on patients' own descriptions. Research into similar conditions suggests such diagnostic uncertainties often undermine the perceived 'realness' and legitimacy of the condition and its treatment. In contrast, burnout seems to be considered a 'genuine' medical condition in the Netherlands, granting access to financial compensation, psychotherapeutic treatment, rehabilitation and up to two years' paid leave from work.

To examine this phenomenon, we explored how burnout is perceived and understood. Of particular interest was the feedback between society's ideas and perceptions of the condition, and those of the individuals suffering from it. Eighteen patients were involved in the research that was carried out via in-depth narrative interviews, alongside interviews with five physicians and seven occupational health specialists. The interviews

showed that burnout patients were often associated with characteristics such as being loyal, dutiful, dedicated and hard working. Some were even described as "the perfect employee", or in the words of one physician: "The tired hero [who] always worked hard and gave it all." As another physician explained: "[Burnout] implies that you really worked hard, so burnout is actually quite cool." Such discourses may be understood in light of wider Dutch norms, historically rooted in Protestantism, by which hard work is a virtue. Another participant explained how this might affect attitudes towards patients: "If someone who really busts a gut gets burned out, people have respect for that." Hence, these hard-working individuals may become regarded with a degree of admiration, leading to a positive self-image: "Softies do not burn out. You need to work very hard to get burned-out." These perceptions and ideas associated with burnout help explain why the condition is viewed as relatively legitimate, in contrast to conditions such as chronic fatigue syndrome – where similar diagnostic uncertainties exist, but patients generally experience much less recognition and acceptance. Ω



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The Tired Hero: A qualitative study of the social meaning of burn-out in the Netherlands. Master's thesis J.J. Boersma, UvA (2014).

Matching probabilities and loop models



BERNARD NIENHUIS is Professor of Condensed Matter Theory at the Institute for Theoretical Physics, UvA.



JASPER STOKMAN is Professor of Lie Theory at the Korteweg-de Vries Institute, UvA.

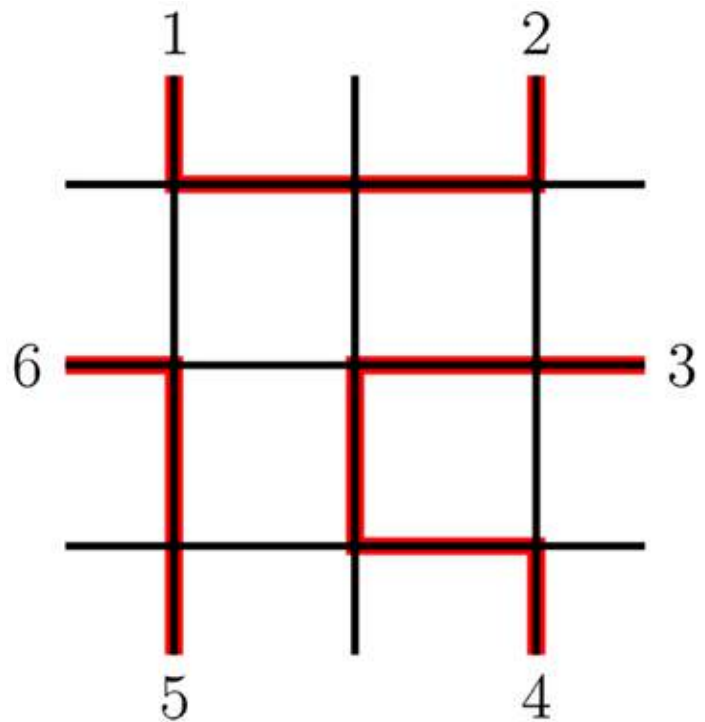
→ In the last decade there has been a growing interest in the connection between combinatorics and statistical physics. This is caused by the remarkable discovery made by Alexander Razumov and Yuri Stroganov [1] in 2004, proven by Luigi Cantini and Andrea Sportiello [2] in 2011, of an unexpected connection between two loop models. Loop models are probability distributions for paths on a lattice. The paths are either closed or terminate on the boundary of the lattice. Here we consider two such models on very different geometries.

Fully Packed Loops on a finite grid

First off, consider a square grid of which the edges are traversed by paths such that each point of the grid is visited by precisely one path and such that every other external edge of the grid is covered by a path (Fig. 1). Such a decoration of the grid by paths is called a Fully Packed Loop (FPL) configuration.

Two external edges are said to be matched by the FPL configuration if they are visited by the same path. In this way each FPL configuration gives rise to a pairwise matching of the occupied half of the external edges. In the example of Fig. 1 those external edges are labelled from 1 to 6, and the FPL configuration yields the following matching $1 \leftrightarrow 2, 3 \leftrightarrow 4, 5 \leftrightarrow 6$.

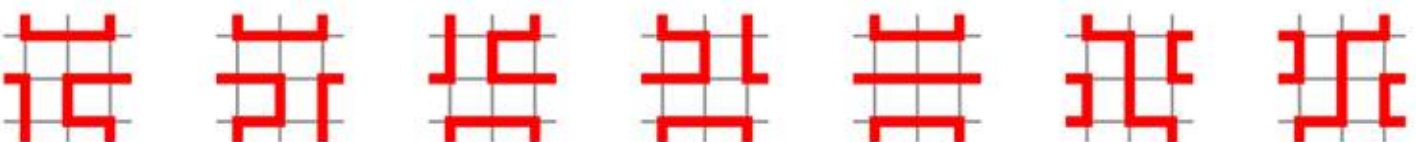
What is the probability of a given matching of the occupied external edges, when each FPL configuration is equally likely? This is a



↑ **Figure 1**
An FPL configuration on a 3x3 square grid. The edges covered by a path are coloured red.

↓ **Figure 2**
The seven FPL configurations on a 3x3 square grid.

counting problem: the probability is given by the number of FPL configurations that produce the chosen matching divided by the total number of FPL configurations. For example, on a 3x3 grid there are two FPL configurations producing the matching $1 \leftrightarrow 2, 3 \leftrightarrow 4, 5 \leftrightarrow 6$ (Fig. 1 is one of them), while there are in total seven FPL configurations shown in Fig. 2. The probability to obtain the matching $1 \leftrightarrow 2, 3 \leftrightarrow 4, 5 \leftrightarrow 6$ thus equals $2/7$.

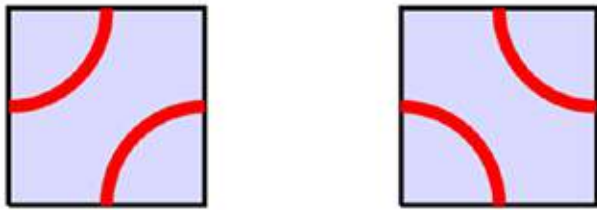


Completely Packed Loop model on a half-infinite cylinder

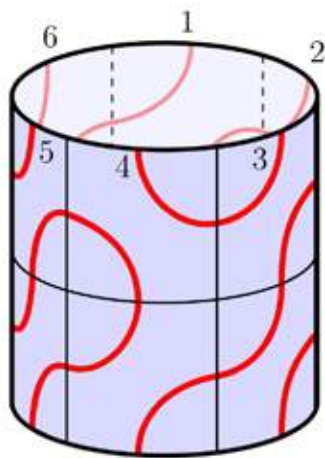
Now consider non-intersecting paths on a square lattice on a half infinite cylinder, such that each edge is traversed once, and consequently each vertex is visited twice. It can be seen as being built up from the tiles shown in Fig. 3.

↓ Figure 3

The two possible tiles of the CPL model.



This is called the Completely Packed Loop (CPL) model. As in the FPL model, all path configurations are equally probable. Fig. 4 shows a possible configuration of the top two layers.



↑ Figure 4

The top two layers of a CPL configuration on a half-infinite cylinder.

Again, each configuration determines a matching of the endpoints of the paths at the circular rim of the cylinder (see Fig. 5). Computing the matching probability in the CPL model is not a counting problem, since there are infinitely many CPL configurations (each equally probable).

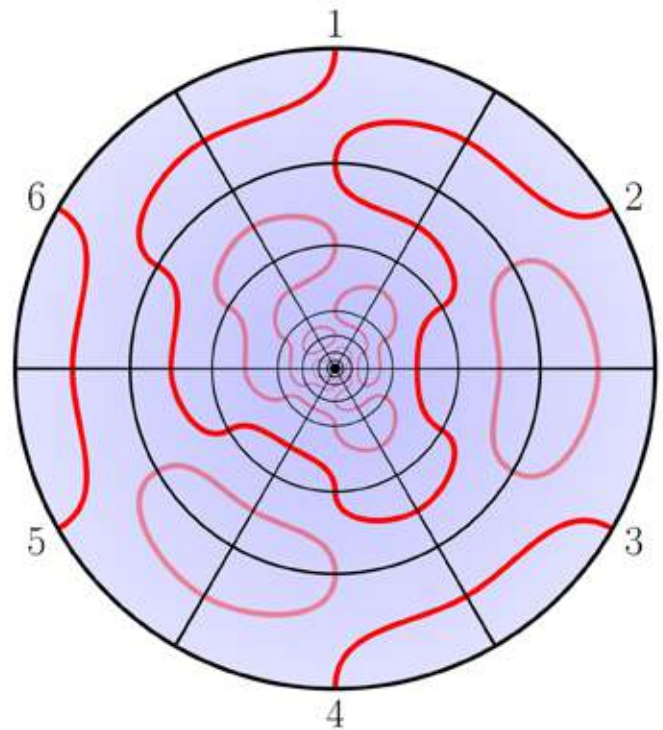
The surprising connection

Razumov and Stroganov [1] discovered that the probability that a specific matching results from a randomly chosen CPL configuration on the cylinder is the same as the probability that it is induced by a randomly chosen FPL configuration on the square grid. The conjecture was proven by Luigi Cantini and Andrea Sportiello [2] but their proof did not provide a conceptual understanding of this surprising fact.

Generalisations and future developments

In the meanwhile, the Razumov-Stroganov conjecture has been generalised in many ways, to different geometries, boundary conditions, and model rules. The guiding principle here is *integrability*, a very special feature of the models and their generalisations which, in case of the CPL model, is reflected by the remarkable property of the model that the matching probabilities are unaltered if the tile bias is changed, i.e. if one tile is favoured over the other. The generalisations have led to a host of interesting new conjectures of correspondences, and of explicit expressions for probabilities of certain events. Few of these have been proven.

A natural generalisation of the CPL model is obtained by allowing the



↑ Figure 5

Inside view of a CPL configuration producing the matching $1 \leftrightarrow 2$, $3 \leftrightarrow 4$, $5 \leftrightarrow 6$ at the circular rim.

tile bias to differ for each column on the half-infinite cylinder. The dependence of the corresponding matching probabilities on the column biases is governed by a well-known set of equations in mathematical physics, called quantum Knizhnik-Zamolodchikov equations. It is hoped that cutting-edge techniques from mathematics and theoretical physics will demystify and generalise the mysterious connection between the matching probabilities. We are both actively involved in this exciting research area [3,4] and are currently co-supervising a PhD-project on this topic.

Acknowledgments: We thank Jim de Groot (Master's student in Mathematics at the UvA) for his help in producing the figures. Ω

“The generalisations have led to a host of interesting new conjectures”

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Organised chaos in the brain



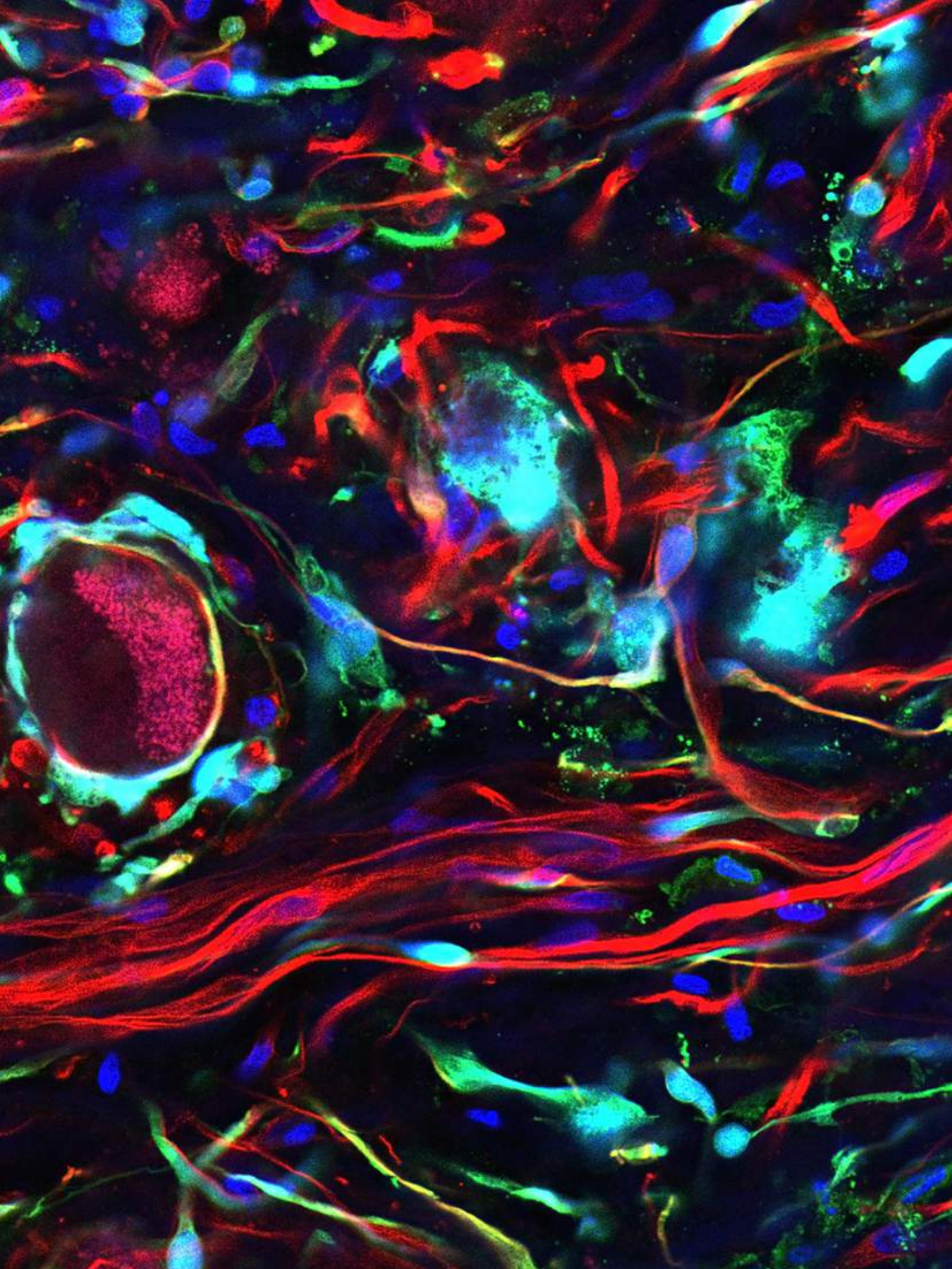
A human dorsal root ganglion labelled with fluorescent proteins (green). Ganglia are clusters of nerve cells; this particular ganglion contains the cell bodies of sensory neurons that carry information towards the spinal cord. The neurons in the ganglion are stained red and the nuclei of the cells blue. The tissue was obtained from a post-mortem autopsy in collaboration with the Netherlands Brain Bank.

This image was entered in "The Art of Neuroscience" (<http://aon.nin.knaw.nl>) [AoN] competition. AoN was initiated by Dr. Tycho Hoogland (Erasmus MC, Rotterdam) and launched in 2010 at the Netherlands Institute for Neuroscience in Amsterdam. It now curates hundreds of image and video submissions from artists and scientists across the globe. The goals of the AoN initiative are to raise awareness of the importance of neuroscience research, of the inherent beauty found in nature, and to spark a dialogue between scientists and artists.

Photograph

STEFAN A. HOYNG

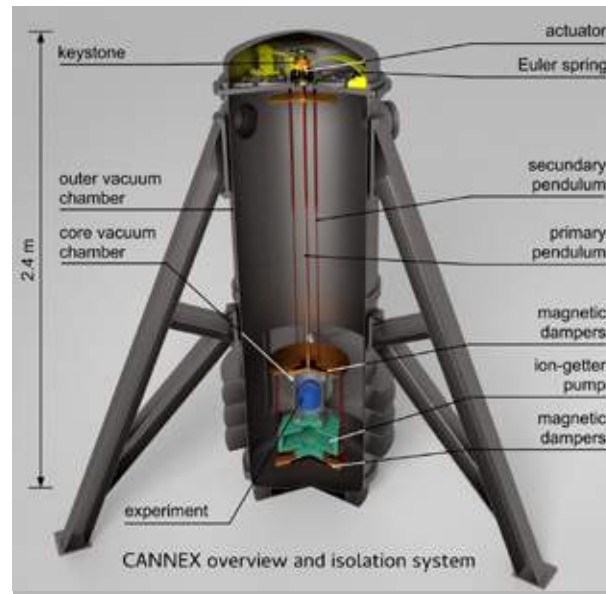
PhD candidate at the Netherlands Institute for Neuroscience.





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RENÉ SEDMIK is postdoc and lecturer
at the Department of Physics
& Astronomy and LaserLaB, VU
University Amsterdam.

The CANNEX experiment: dark energy, tabletop scale



→ Figure

Cut-through view of the CANNEX experiment. The actual measurements take place in a small 'core chamber' hung separated from the outer world by a bi-directional vibration-insulation system inside a large vacuum chamber.

Dutch physicist Hendrik Casimir first described the force between two very closely spaced, parallel, neutral conducting plates due to the zero-point energy of the quantised field (or vacuum fluctuations) in between the plates.

→ The accelerated expansion of the universe is a long-known fact – as is the pragmatic explanation that a negative pressure field called 'dark energy' generates it. Yet, the mechanisms behind dark energy are unknown. Numerous theories have been developed to shed light on the subject, but few pass experimental tests. We have developed an experiment aiming to test a promising candidate theory coined the 'chameleon model'. Recently, first tests revealed that our set-up may indeed be up to the task.

Dark energy and the expansion of the universe

One century ago, Einstein recognized that the solutions of general relativity corresponded to a universe that would collapse or explode before stars or galaxies could form. To render his universe static, he introduced the cosmological constant Λ , representing a background of negative pressure.

Nowadays, this background is referred to as 'dark energy' and the value of Λ has been determined precisely from measurements of the cosmic microwave background. So far, all astronomical observations agree with the predictions of the cosmological standard model built

upon Λ . However, the presence of a uniform pressure background seems unnatural and goes against physical intuition.

Theorists have therefore come up with numerous viable alternatives to the cosmological constant. One particular theory predicts forces that vary with the local density of matter. In the vast empty spaces between galaxies, the interaction would be strong, while in our Milky Way or on Earth, it would be exponentially suppressed. It is this adaptation for which the theory earned its name as the 'chameleon model'.

A new experimental approach

In 2010, a new way to detect chameleon interactions was suggested, namely by using a precision measurement of forces between parallel plates [1]. If the pressure

of an ambient gas around the plates is increased, the 'standard' electrostatic, gravitational and Casimir interactions would increase, but the chameleon force would decrease. This qualitative difference potentially results in a high sensitivity to chameleon interactions. The theory contains two unknown parameters n and, defining the reach and strength of the forces. If an experiment finds no 'non-classical' effects, we can set tighter bounds on the possible values of n and, based on the sensitivity of the measurement. If, on the other hand, unexpected effects are found, this would indicate that our current picture of physics requires revision by adding chameleon forces.

Five years of development

In 2011, we started to design a set-up realising the 'Casimir And Non-Newtonian force Experiment' (CANNEX). While the measurement principle is simple, the actual implementation tottered on the borders of technical feasibility. In order to cover the entire range of n and β not yet excluded by other experiments, we had to reach a sensitivity of 0.1 pN between parallel plates of 1 cm², spaced 10–30 μ m apart. This implies that the flatness and parallelism have to be better than 10 nm over the entire surface, which is the equivalent of a deviation of at most 0.2 mm over the length of the Bosbaan rowing course in the Amsterdamse Bos. Near-perfect isolation (see Figure) against vibrations, electric fields and sound had to be developed. Without this shielding, our capacitive force measurement would be disturbed by an ant crawling at a distance of 100 m from the set-up.

A first success

Recently we conducted a first test of our sensor [2], which revealed the limits for the theoretically achievable sensitivity of CANNEX. In the current configuration, a limiting sensitivity of 1.2 pN appears possible, which compares well to the performance of other experiments. With improvements, we expect that we can reach 0.3 pN and reduce the limits on β by roughly two orders of magnitude. In order to achieve our final goal of complete coverage with 0.1 pN, the temporal and financial lifelines of CANNEX have to be extended, and several problems would need to be tackled successfully. Ω

→ Reference

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- 2] A. Almasi et al., Force sensor for chameleon and Casimir force experiments with parallel-plate configuration, *Phys. Rev. D* 91, 102002 (2015).

“CANNEX could help us rule out or confirm viable theories for dark energy.”

Flexibility

by Renée van Amerongen



©

RENÉE VAN AMERONGEN is MacGillavry fellow and tenure-track assistant professor at the University of Amsterdam in the section of Molecular Cytology at the Swammerdam Institute for Life Sciences.

→ What do acrobats and scientists have in common? They both bend over backwards to get their job done. Now I must admit that I don't know too many circus performers, but I do know that scientists would give them a run for their money when it comes to being flexible. We don't care about working crazy long hours. We come to the lab on weekends and if necessary we stay well into the night. We often move across the world to follow our intellectual passion, leaving family and friends behind. And yet, when it comes to job security, many of us might just as well have joined the circus.

After jumping through the hoops of getting my PhD and doing a successful postdoc abroad, after showing that I can do science, publish papers and acquire my own funding I am still on a temporary contract, hoping to jump through that last hoop at the end of my tenure track. I am not complaining – I love my work. And I know that I am one of the lucky ones. But would I like to have a steady job by now? Sure, once you're nearing 40 and have about as decent an academic career as you possibly could have built for yourself, it would be nice to know whether you can settle down at a given location and buy a house.

Luckily, politicians and lawmakers have come to our rescue. The so-called 'flex-law' (the Dutch 'flexwet' on flex-workers) aims to protect employees from too many consecutive temporary contracts. It forces employers to offer people a permanent job after working for four years on temporary contracts or after two extensions of a temporary contract – whichever comes first. Well, The Hague, this is your wake-up call: those permanent jobs do not exist! With the current amount of money you are willing to spend on science, universities and research institutions cannot

offer permanent staff positions to most scientists, no matter how brilliant or technically skilled they are. Of course, the politicians don't believe this. After all, the Secretary of State for science, Sander Dekker, is always proud of how much Dutch science can do with so little. In reality, every scientist knows that those permanent contracts will not suddenly appear. And so, paradoxically, the 'flex-law' is especially hurting the most talented researchers: the people who want to have an academic career.

As a junior group leader I spend a lot of my time writing grants. These grants pay the salary of most people in my research team, including a postdoc and a technician. Thanks to the new, stricter flex-law, I now have to let all of them go after four years. So should everybody just get a permanent job? No. A postdoc doesn't need to get a permanent contract. What should be the case, however, is that he or she should be the one in control of his/her own mobility.

Nowadays, it is not uncommon for people to do two postdocs and sometimes even more. In biomedical research, four years is also the minimum amount of time it takes to collect sufficient data for a high-quality paper (one of the aforementioned hoops). Then there is the pressure to obtain independent funding (another hoop), which has the huge upside of being able to fund your own research for a few more years. Thanks to the flex-law, however, I can only hire the same postdoc for a maximum of four years. This implies, that the most talented young scientists are forced out of the lab.

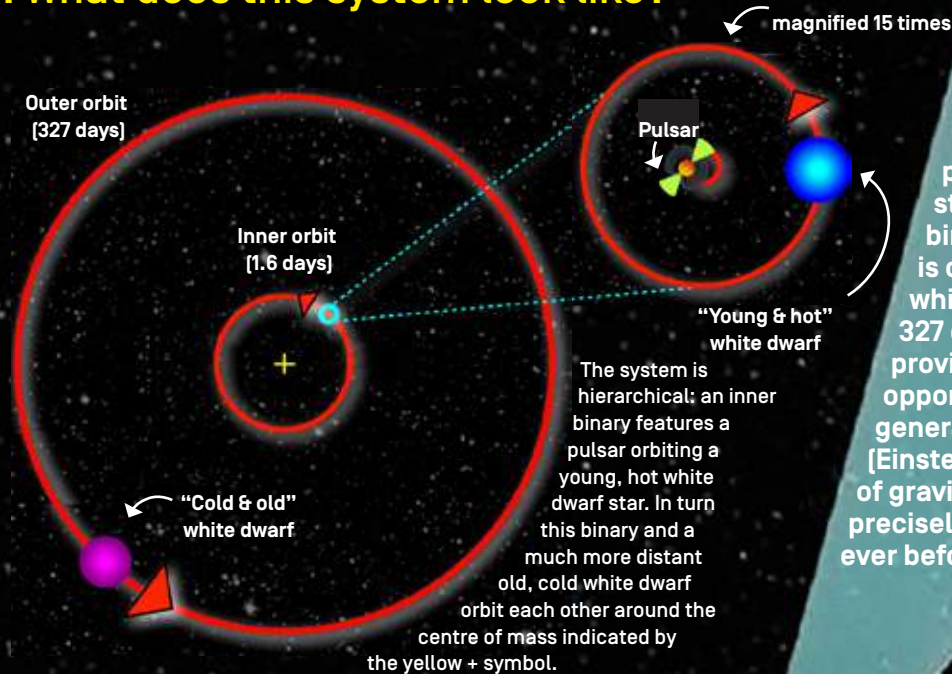
One ungainly option is to let them collect unemployment benefits for a few months, after which they can be re-hired. Since the competition doesn't sit still, it is not too uncommon to hear stories of people who come into the lab

to work while – technically speaking – being unemployed. Under the new law, however, the minimum time required between contracts has been extended from three to six months. It is already too crazy that some of our most highly educated people are working long hours while unemployed, but it is beyond ridiculous if they would have to do this for six months.

Of course no one is forcing them to stay. They are free to pack their bags, take their personal grants and move to a different university, provided this would be a suitable research environment. But someone's scientific trajectory shouldn't be dictated by a law that is clearly not fit for 21st-century science. Sadly, the only thing more worrying than the monstrosity that is the new flex-law, is the clear lack of understanding it reveals in our political leaders as to how science actually works.

A cosmic clock in a triple star system

1. What does this system look like?

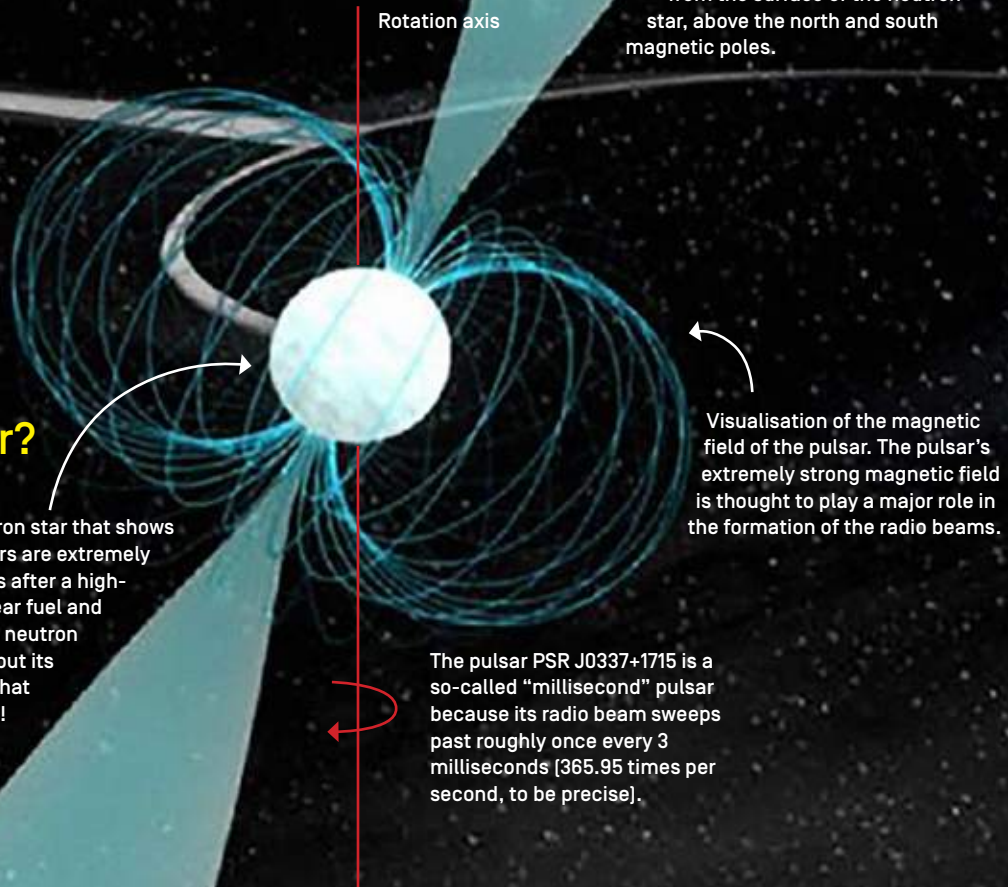


In 2014, an international team of astronomers, including Anne Archibald and Jason Hessels of the UvA, discovered PSR J0337+1715, a unique pulsar in a triple star system [1]. This pulsar orbits a white dwarf star every 1.6 days. This binary system, in turn, is orbited by another white dwarf every 327 days! This trio provides us with the opportunity to test general relativity [Einstein's theory of gravity] more precisely than ever before.

Radio beam of the pulsar: a cone of light originating from the surface of the neutron star, above the north and south magnetic poles.

2. What is a pulsar?

A pulsar is a special type of neutron star that shows pulsations as it rotates. Neutron stars are extremely dense; they are all that remains after a high-mass star has exhausted its nuclear fuel and exploded in a supernova. A typical neutron star weighs as much as the Sun, but its diameter is not much bigger than that of Amsterdam!



[1] Ransom, Stairs, Archibald, Hessels et al., Nature 505, 520 (2014).

Figure credits: Bill Saxton, NRAO (millisecond pulsar formation, 4 figures), Bill Saxton, NRAO (pulsar and Earth, adapted), Bill Saxton/NRAO/AUI/NSF (background), Jason Hessels (schematic system).

6. The equivalence principle & testing general relativity

According to the equivalence principle of general relativity, a box of feathers and a box of lead dropped at the same time, from the same height, will hit the ground simultaneously. This is true for gravity like that on earth, but does this also hold when gravity is really strong as for ultra-dense stars? The triple star system depicted here allows us to test this. As the

pulsar-dwarf pair and the old, cold white dwarf orbit each other, the pulsar and inner white dwarf are "falling towards" the outer white dwarf, and according to Einstein's theory, this should happen in a way that doesn't depend on their composition. Currently, the team is analysing the observations to find out whether Einstein's theory will pass this test...

3. What is a white dwarf?

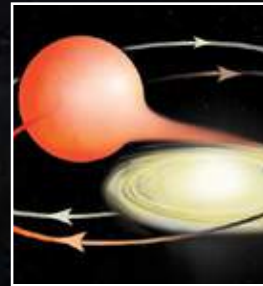
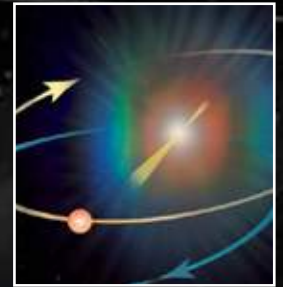
When a star is not too massive, it turns into a white dwarf after it runs out of fuel. The matter of a white dwarf is very compact (though not nearly as compact as a neutron star): on Earth a teaspoon of this material would weigh as much as an elephant. The triple star system contains two white dwarfs: a hot, young white dwarf, and an older one, that has cooled down over time.

4. What makes millisecond pulsars spin hundreds of times per second?



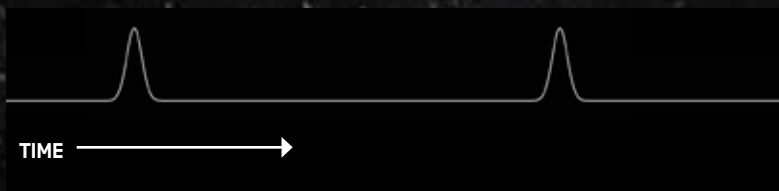
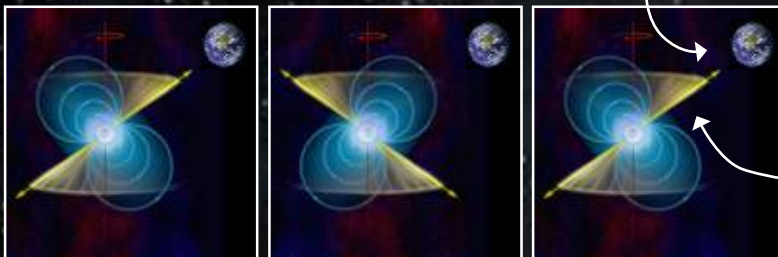
4a. Two normal stars orbit each other.

4b. The more massive star [white/blue] burns through its fuel first and explodes, leaving behind a pulsar. Because the original star was rotating, the pulsar rotates too.



4c. Billions of years later, the other star burns out and expands, leaking matter from its surface to the pulsar. Since this matter is rotating, the pulsar's spin is sped up to hundreds of revolutions per second.

5. Why are pulsars "cosmic clocks"?



A pulsar appears like a lighthouse. Although the radio beam shines constantly, the rotation of the pulsar causes it to sweep past the observer, producing a pulse. The rate of the pulses is so regular, that pulsars are sometimes referred to as 'cosmic clocks'. We can use the pulses as the ticks

of a clock in order to infer how quickly the pulsar orbits around the two white dwarfs. This can be done with extreme precision, especially in the case of millisecond pulsars: e.g., the inner and outer orbital periods of PSR J0337+1715 are both known to one part in a billion!



4d. The outer layers of the second star are blown away by the intense radiation of the pulsar and only its compact core is left: a white dwarf.

The battle between plants and pathogens: they can't win, but we can lose



FRANK TAKKEN is Associate Professor Molecular Plant Pathology at the Swammerdam Institute for Life Sciences (SILS), UvA.



➤ **Figure 1**
Tomato plants infected with the fungus *Fusarium oxysporum*. The plant on the left carries the I-2 NLR immune receptor and induces its immune responses upon pathogen recognition, thereby halting infection. The plant on the right does not have this receptor and cannot recognise the fungus. Hence it gets infected, showing the typical symptoms of *Fusarium* wilt disease.

→ Like any other living being, plants can become diseased. Diseases reduce the quality and quantity of our crops, causing famine and malnutrition during epidemics. So why do plants get sick? The reason is that pathogenic microbes attack them, and although plants have a sophisticated immune system, pathogens can breach it, with disease as the result. Plant breeders continuously develop new plant varieties that can resist pathogens, but unfortunately once the resistance these plants possess can be overcome, the crop is once again vulnerable to attack. New insights from our group on how plant immune receptor proteins function and how they lead to plant immunity provide new, alternative strategies to combat pathogens and could even lead to the construction of an artificial plant immune system.

Domestication and arms race

Ever since mankind started to cultivate plants some 10,000 years ago, farmers have searched for plants with the highest yield, best nutritional value and taste. In the middle ages the grower also became a plant breeder by selecting the best performing plants from which to isolate seeds. These then formed the basis for the next generation of plants the year after. This selection process resulted in the development of so-called 'land races' – varieties best adapted to the local field conditions. The rediscovery of Mendel's law in the beginning of the 20th century – that traits are heritable and inheritance can be predicted – revolutionised plant breeding. The potential for crop improvement was readily recognised as a commercial opportunity and many plant breeding companies have their origin in that century.

“On average 35% of the annual harvest is destroyed by pathogens.”

By setting up targeted crosses, and by selecting the best performing varieties in the field, hybrids were obtained with superior qualities. The discovery of DNA in the 1950s as the carrier of genetic information and the finding that traits are encoded by specific genes has sped up the selection process dramatically. The desired plant can now quickly be identified in a population by analysing its DNA rather than *via* lengthy laborious field trials. This has revolutionised plant breeding and formed the basis of what is called the 'green revolution', in which novel, high-yielding varieties are combined with modern cultivation techniques. The result has been a massive increase in agricultural production worldwide. Yet, the increase in production of many crops is levelling off, raising new challenges for the future. One of the biggest threats is that of pathogenic microbes.

In and by themselves, these microbes are nothing new. Ever since the domestication of our first crops, pathogenic microbes have taken their share (Fig. 1). The losses caused by various pathogens differ, but they can be as high as 80% for rust fungi, which invade a wide variety of hosts, ranging from soybean and rice, to coffee shrubs. In addition to overall losses, the quality of our food and feed is threatened by pathogens, because of the toxins secreted during the infection process. Unfortunately, these pathogens prove hard to defeat. New pathogenic strains emerge frequently, causing outbreaks to which our crops are vulnerable. Notwithstanding the use of fungicides and pesticides, on average 35% of our annual harvest is destroyed by pathogens, a percentage that is predicted to increase as a result of climate change. Whereas plant breeding has shown its power in boosting crop yield and quality, breeding for resistant plants remains a major challenge. There are exceptions, but most resistances that have been introduced from wild and cultivated plant species into our elite crop varieties are overcome within a few years after their introduction in the field. This forces a continuous search for new sources of resistance; breeding these into an elite variety typically takes 8-10 years.

This never-ending 'arms race' between pathogen and plant breeder forces the latter to engage in a battle that can never be won, but that can be lost. A confounding problem is that there is a limit to the number of natural resistance genes and the spectrum of pathogens that they are able to recognise. Moreover, even when a resistant plant source is available, it cannot always be used for crosses. Therefore, we need to understand how pathogen resistance in plants functions, so as to allow the development of a proactive rather than a reactive strategy.

The plant immune system

Different from what their appearance suggests, plants are not sitting ducks. In fact, plants are very capable of defending themselves against microbial infections. They do so, for instance, by building barriers such as cell walls and putting a layer of wax on their leaves. Pathogenic microbes, however, have found ways to break through these barriers. To counteract such pathogens, plants have developed a sophisticated recognition-and-defence system. Each individual plant cell carries its own innate immune system and is capable of defending itself. This system allows a plant cell to recognize 'non-self' molecules that are released by the pathogen during infection, and this pathogen recognition leads to activation of a local immune response as well as a systemic response that provides protection against a broad spectrum of microbes.

Key to the defence system are immune receptors: proteins that mediate pathogen recognition and activation of a defence response. As a PhD student at the VU University Amsterdam I was part of the team that identified one of the first immune receptor genes. This was the *Cf-4* gene of the tomato that confers resistance to leaf-mould disease. Since then, many immune receptors have been identified in a variety of plants, and the majority turned out to encode so-called 'NLR-type proteins' (the acronym NLR designates nucleotide-binding and leucine-rich repeat domains). Our lab went on to pioneer the functional characterisation of these multi-domain proteins, and we were the first to show that these proteins act as molecular switches, whose activation

state is controlled by the exchange of an ADP molecule for an ATP molecule. Our next discovery – that hydrolysis of ATP into ADP resets the receptor into its resting state – prompted us to propose the first working model of an NLR protein. In this 'switch model', which was published in *Science* in 2009, the activation state of NLRs is controlled by intramolecular rearrangements upon pathogen perception. In the resting ('off') state, the NLR protein is ADP-bound, but upon pathogen detection its ADP is exchanged for ATP. Binding of ATP is proposed to trigger a conformational change that allows the now activated ('on') NLR protein to trigger defence signalling (see Fig. 2). ATP hydrolysis returns the protein to its off state. Structural modelling of NLR proteins has provided some insight into how these proteins function as sensors of 'non-self' molecules and how they switch between the on and off state. However, to date structural models have been unable to explain how activated NLR proteins initiate the defences of the host.

Novel insight in immune receptor function: promises for the future?

A major question, therefore, is how pathogen recognition by NLR proteins is ultimately translated into an effective immune response. In particular, the identity of the response factors targeted by an activated receptor represents a major gap in our knowledge. Studies in our labs and those of others have recently shown that some immune receptors act in the plant nucleus. This was surprising, because plant immune receptors were believed to be active in the cytosol (the jelly-like fluid of the cell). Like their mammalian counterparts, plant NLRs were thought to interact with other cytosolic signalling proteins thereby starting a signalling cascade that eventually results in the induction of an immune response. However, despite extensive genetic and biochemical searches no signalling proteins interacting with plant NLR receptors have ever been found.

When we analysed modelled structures of the central Nucleotide Binding (NB) domain of plant NLR proteins, we noticed that this domain has structural similarity with DNA binding proteins. To →

“Each individual plant cell has its own innate immune system and is capable of defending itself.”



↑ Figure 2

A healthy tomato plant (left) and one suffering from autoimmune responses (right). The plant on the right suffers from a permanently activated immune response due to the aberrant activation of its I-2 NLR immune receptor. These paranoid tomato plants that are fighting an imaginary pathogen are used as models to study the plant immune system. Photograph courtesy of Di Xiaotang.

↘ Figure 3

DNA binding and bending model for NLR receptor activity. Recognition of the *Fusarium*-derived Avr2 protein triggers a conformational change in the multi-domain NLR protein I-2 allowing the ATP bound state of the protein to bind and subsequently bend DNA, thereby inducing defence gene expression and immunity. Colours indicate the different domains in NLR proteins: orange designates the CC/TIR interaction domain; red, purple and blue subdomains together form the Nucleotide Binding (NB) domain; green represents the Leucine-Rich Repeat (LRR) domain.

→ Reference

- [1] S. Fenyk et al., The Journal of Biological Chemistry 290, 24945-24960 [2015].
- [2] S. Fenyk et al., The Journal of Biological Chemistry 291, 1137-1147 [2016].

gether with the group of Martin Cann (Durham University, UK) it was found that "in vitro" the NB domain of a potato NLR protein – called Rx – not only bound DNA but also bent it, thereby partially unwinding the double helix. Following up on these exciting observations, we analysed DNA binding by Rx in the more natural setting of plant leaves. We found that DNA binding only occurred when Rx was activated following recognition of the pathogen. This finding identifies DNA binding by an NLR protein as a specific, essential and very early step in immune signalling in plants [1].

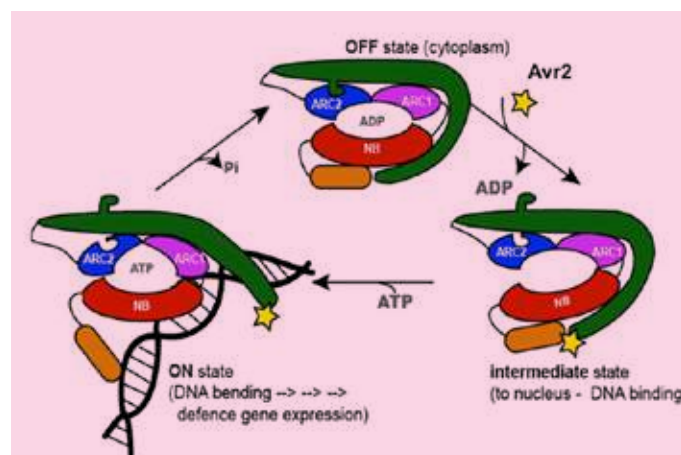
Inspired by these results using Rx, we continued our analysis using the tomato immune receptor, I-2. The I-2 protein has ATPase activity "in vitro", allowing us to study the previously identified role of nucleotide binding and hydrolysis in relation to its ability to interact with and bend DNA.

“Can we artificially trigger a plant’s immune response?”

We found that only activated (i.e. ATP-bound) I-2 binds to DNA – and that it is this DNA binding that stimulates the protein’s ATPase activity, returning it to its resting

(i.e. ADP-bound) state. This in turn causes I-2 to dissociate from DNA [2]. Such a cyclic mechanism would allow I-2 to become re-activated and rebind to DNA. These observations not only fit perfectly to the switch model that we proposed earlier based on molecular data, but now this new variant of the model can also be linked to a molecular target in the host cell (Fig. 3) that, in contrast to the current dogma, is not a signalling protein but DNA.

How immune receptor activation leads to its action on DNA and how this action is translated into a cellular defence response remain crucial, unresolved questions. My group is addressing these issues, together with my collaborators, in a research line that recently received funding by a Vici grant by funding agency NWO. Knowing how activated NLR proteins trigger immunity might allow us to improve the activity of weak variants or to broaden their spectrum, so as to allow detection of pathogens that currently evade recognition. An even more exciting challenge is to find out whether artificially mimicking the activity of an activated immune receptor on plant DNA can trigger the plant immune response. If so, the creation of an artificial immune system for plants, based on the same principles but no longer restricted by natural NLR availability, would become a possibility. If new resistance traits can be generated and deployed faster than pathogens evolve, a durable strategy for disease control in our crops would come within reach.



Q

1. The first experiment I ever did was...

... during my biology studies. I was doing my major in Suriname and the experiment was to collect water plants for the flora of Suriname. During that time, I got intrigued by beetles residing inside water lilies. I sent a couple of beetles to Amsterdam and, by doing so, to my surprise, I had apparently found support for a theory of my professor at the UvA. Another interesting experiment I did was on biological control of diseases in apple trees.

2. My constant source of inspiration is...

... interaction with people, particularly with experts in companies who join me in developing ideas and concrete strategies to improve sustainability in industry.

3. One book that I recommend to all young scientists is...

... *Our common future* by the World Commission on Environment and Development (1987). I would like to recommend this book because it marks the rise of sustainability in an inclusive way.

4. If I headed the Ministry of Science the first thing I would change is...

... the rat race to publish as many papers in academic journals as possible. I feel the pressure in the academic world to publish is becoming counterproductive. I would prefer quality over quantity. Also, the academic world should be more open to playing other roles, for example by talking to a broader audience about their research and making it in general multi-faceted instead of being monodisciplinary. In brief, I would like to change the overly competitive structure of academia.

© JACQUELINE CRAMER UvA graduate and former Minister of Housing, Spatial Planning and the Environment; currently professor in sustainable innovation at Utrecht University, and member of the Amsterdam Economic Board.

5. If I had to switch roles with a famous person for one day, I would choose to be...

... Jacqueline Cramer. I am perfectly happy and comfortable being who I am right now. I don't see myself performing and functioning similarly in any other role.

6. I am most creative when...

... I give myself the time to reflect upon things and not feel pressured to produce output immediately. I think creativity comes from not being biased and trusting your intuition, it appears when leaving room for new impulses which make you think more openly, hence leading to new ideas.

7. If I could choose my field of study and university once again I would choose...

... the field of sustainability in its present form. When I started studying, this topic did not exist. Even the field of environmental studies was just being set up and was mainly focused on earth sciences, chemistry and biology, with little attention for social sciences and economics.

8. When I am not being a scientist I am mostly...

... an artist. I would like to develop my musical skills and also try to express myself artistically. However, unfortunately, I did not develop these skills all that much up to now.





©
TIES KORSTANJE performed this research as a postdoctoral researcher in the Van 't Hoff Institute for Molecular Sciences of the UvA.

Alcohols made sustainable

→ Almost all man-made chemicals are currently produced from fossil resources such as oil and natural gas. It is desirable to switch to a sustainable sourcing of chemical feedstock, for example by using non-edible biomass. However, such a major change of source demands the development of a novel type of chemistry, because the molecules in biomass contain much more oxygen (in the form of, for instance, esters or carboxylic acid groups) compared to traditional fossil feedstocks. One method to reduce the oxygen content is via hydrogenation: a reaction with molecular hydrogen (H_2) to remove (part of) the oxygen as water (H_2O).

Hydrogenation reactions require catalysts. Currently, these are typically based on noble metals, which are expensive, scarce and often toxic. Therefore, to make the hydrogenation process really sustainable, we need catalysts based on cheap, abundant and non-toxic metals. Recently we have shown, for the first time, that a catalyst based on the highly abundant

metal cobalt can hydrogenate carboxylic acid groups to give alcohols. Using a cobalt/triphos catalyst (see Figure), a broad range of carboxylic acids could be hydrogenated under relatively mild conditions, thereby also requiring less energy and making the process greener still.

Some of the carboxylic acid starting materials can be easily obtained from renewable resources, and their alcohol products are chemicals widely used in everyday products and processes. Succinic acid, for instance, can be efficiently hydrogenated to 1,4-butanediol, which is used to make polyesters for the automotive industry. Another interesting reaction is the hydrogenation of stearic acid, a fatty acid, to give stearyl alcohol, a common emulsifier in creams and lotions.

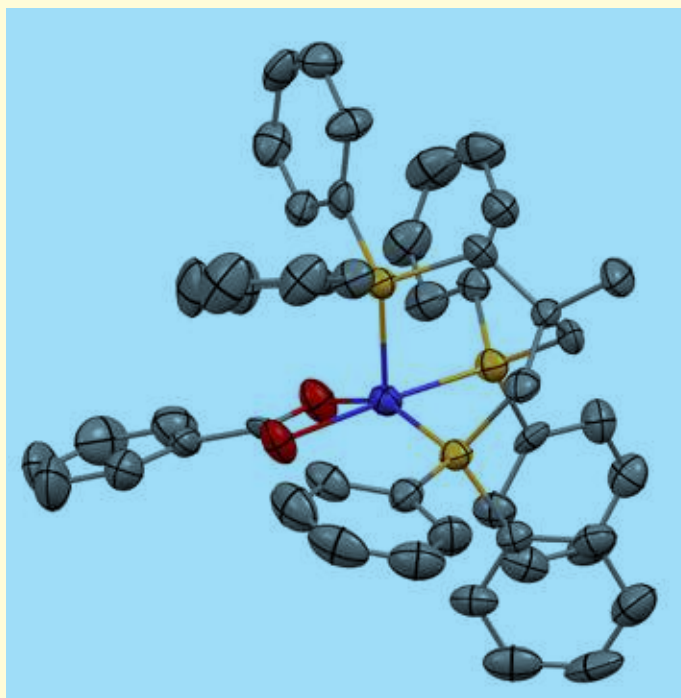
With the discovery of this efficient catalytic system, we have made an important step forward towards valorising non-food biomass so as to produce industrially important alcohols in a sustainable fashion. Ω

→ Figure

The crystal structure of the cobalt/triphos catalyst with a benzoic acid molecule attached to it. The cobalt atom is shown in purple, with the benzoic acid on the left [attached via the two oxygen atoms depicted in red] and the triphos ligand around it [attached via the three phosphorus atoms depicted in yellow].

→ Reference

T.J. Korstanje, J.I. van der Vlugt, C.J. Elsevier, B. de Bruin, Hydrogenation of carboxylic acids with a homogeneous cobalt catalyst, *Science* 350, 298-302 (2015) – <http://science.sciencemag.org/content/350/6258/298>



Amsterdam Data Science:

To advance and enable data science research across disciplines

Amsterdam Data Science (ADS) started in February 2015 as a collaborative initiative of the Informatics Institute of the Universiteit van Amsterdam (UvA), the Department of Computer Science of the Vrije Universiteit Amsterdam (VU), the Centrum Wiskunde & Informatica (CWI) and Hogeschool van Amsterdam (HvA). In addition, the Amsterdam Business School and the Amsterdam School of Economics participate, while the medical centres, AMC and VUmc, are the partners in Health Sciences.

ADS connects data science researchers from academia, industry and government to share ideas, pursue research and foster talent. The researchers are experts in a range of themes, encompassing business

analytics, digital humanities, informatics, life sciences and social sciences. Within these themes, the focus lies on: city analytics, creative industry, health, intelligence and security, and logistics. In the past year new collaborations have been initiated and with Ahold (Food retail), Elsevier Publishers, iQU (games marketing), National Police (Landelijke Politie), ORTEC (civil engineering), Philips, and VU Medical Center (VUmc) (see Figure). The Amsterdam DataLab, a unique initiative by the City of Amsterdam will provide access to open data from the local government.

The key goal of ADS is to advance and enable data science research across disciplines, research institutes and industry within the Amsterdam region. Seed projects

“Seed projects in 2015 covered a wide array of topics.”

in 2015 covered a wide array of topics. For instance: “Consistent availability of large clinical datasets through persistent identifiers”, which is aimed at providing technology to store, search and analyse large datasets obtained from clinical research. Another project: “Implementing online visualizations for Machine Learning applications” aims to develop understandable and usable uncertainty visualizations that facilitate user adoption of Machine Learning technologies, and that support user awareness of uncertainty in end-results. ADS researchers have developed a Data Science track in the joint UvA-VU MSc programme in Information Studies that will commence in September 2016. Ω

Website:
<http://amsterdamdatascience.nl/>

→ Figure

An overview of the Amsterdam Data Science connections across research domains and with local industry



Science start-ups and spin-offs



©
ELINE VAN DILLEN
Department of Communication,
Faculty of Science, UvA

→ “**Amsterdam: start-up capital of the European west coast**”, the website of the city of Amsterdam proudly announces. It goes on to explain that ‘our city’ is the best incubator for small start-up companies. The facts indeed support this claim. For example, Amsterdam currently holds the second place in the European Digital City Index, an indicator of the level of support that various European cities provide to digital entrepreneurship. So, Amsterdam does offer a favourable climate to those wishing to start their own company. But how do scientists with a good idea for a business get started?

An answer to this question can be found in the Amsterdam Science Park, where incubator ACE Venture Lab is located. ACE Venture Lab helps science and technology students develop business ideas into start-ups. The lab is connected to both of Amsterdam’s universities and aims to stimulate entrepreneurship in the new

generation of scientists. Participants in the programme include Bachelor’s and Master’s students who have already embraced entrepreneurship during their studies, but also doctoral candidates and alumni who wish to use their knowledge of science for setting up a business. The Venture Lab offers support, from two-day ‘exploratory’ courses for students with a brand-new business idea, to two-year, in-house programmes aimed at consolidating participants’ enterprises. The alumni featured in this issue of Amsterdam Science, Wouter Veerkamp, Manos Tsagkias and Sander Kluwer, all benefitted from the support provided by Ace Venture Lab, as can be read in the interviews on the facing page.

Is there more to Amsterdam’s support of the science start-up scene than the Ace Venture Lab initiative? The answer is yes, and the Innovation Exchange Amsterdam (IXA) is the reason why. Whereas the Ace Venture Lab focuses mainly on students, IXA offers support to research scientists in designing the best strategy for the valorisation of an idea, discovery or invention. A team of business developers, legal and funding ad-

visers supports scientists in getting their ideas funded, setting up spin-off companies and applying for patents. For Sander Kluwer, CEO of the spin-off InCatT, IXA offered support during the patent application process. IXA also has independent financial resources for kick-starting new businesses in the form of its *Proof-of-Concept* fund and *Pre-Seed* fund. New initiatives can compete every year in the *Amsterdam Science and Innovation Award*, a contest for innovative ideas that sprouted from scientific research in Amsterdam and that have social and/or commercial potential. New in this year’s programme is ‘Science Meets Business’, with participants pitching their ideas to a selected group of entrepreneurs, societal organisations and investors. This year the event takes place on Thursday, 26 May.

Both the ACE Venture Lab and IXA regularly welcome students and scientists who are taking their first steps into the world of business. The monthly Venture Café at ACE Venture Lab features get-togethers with like-minded people, at which founders of start-ups and guest speakers share their experiences. Ω

© ACE Venture Lab

ACE Venture Lab is a collaboration between the University of Amsterdam (UvA), VU University Amsterdam (VU), Amsterdam University of Applied Sciences (HvA) and the Amsterdam School of Arts (AHK): <http://www.ace-venturelab.org/>

IXA is the new collaborative entity formed by the TTOs [Technology Transfer Offices] of five institutions: the Academic Medical Centre (AMC), University of Amsterdam (UvA), Amsterdam University of Applied Sciences (HvA), VU University Amsterdam (VU) and the VU University Medical Center Amsterdam (VUmc): <http://www.ixanl/>

Alumni@Work

Where do the alumni of the Amsterdam science community end up in the worldwide job market? This item zooms in on alumni who have started their own science-based company.



Wouter Weerkamp

Founding fathers of startup 904Labs

→ “Bringing some of the cool stuff that is being developed in academia to the market: that was the original goal when I started 904Labs mid-2014,” says Wouter. “By the time Manos joined, at the end of 2014, we had started to focus on one particular piece of technology: self-learning search engines. This is what we currently offer to the e-commerce market: next-generation search technology that learns directly from customer behaviour.”

“We both followed a very similar career path, starting with four years of being a PhD student at the Informatics Institute of the University of Amsterdam. Our research group at that time, called ILPS, focuses on information retrieval, more commonly known as search-engine technology. After graduating, we both spent another two years as postdoc in the same group.”

“At the end of 2013, Wouter decided to leave academia to start a new venture. “Since we already wrote many papers together and were responsible for several courses, it was not a surprise that Manos also joined at some point. At the start of 904Labs, we were part of ACE Venture Lab, an incubator located at the Science Park. The incubator currently hosts about 15 startups: we are all located on the same floor, share a kitchen, and have regular internal and external meetups. Being at ACE



Manos Tsagkias

Venture Lab allowed us to get in touch with CTcue, a startup in the medical domain, with whom we are currently working on a shared R&D project funded by the Netherlands Enterprise Agency.”

“As entrepreneurs there’s a sense of freedom to your working days. No one will tell you what to do and you can decide on your own direction. On top of that, you get to learn many new things, for us mainly on the business side. There are obviously also disadvantages to entrepreneurship: the future is almost always uncertain; you need discipline, since no one will force you to do your job; and you are responsible for your own salary and, even worse, for that of your employees. For this, we are lucky to have obtained a proof-of-concept grant from IXA (Innovation Exchange Amsterdam) to develop particular unexplored aspects of the self-learning search engine.” Ω

→ **Insider’s advice**

“Are you thinking of becoming an entrepreneur? The only good advice is to just give it a go! However, advice is probably the last thing you will listen to, as you’re very likely to be too stubborn to listen to anyone telling you what to do. And that’s probably a good thing.”



Sander Kluwer

CEO of IncatT

→ “Already during my studies at Leiden University and my PhD at the University of Amsterdam I was fascinated by the ability of catalysts to both stimulate and steer chemical reactions. The ability to gain control over molecules and the way they react appeared to me to be the ‘perfect’ way to make new molecules,” explains Sander.

“As I did not see a clear academic path for myself, I also explored the industrial approach to (catalytic) research via internships at Shell and Unilever. After my PhD, I moved to the University of Missouri for a postdoc to investigate various imaging NMR techniques. Then a postdoc position in the Reek Group at the UvA became available which combined both of my main interests: catalysis and spectroscopy.”

“Back at the UvA I was introduced to the exciting world of spin-off companies. I joined a freshly started spin-off company called Cat-Fix, bringing novel catalyst capturing technology to the market. Two years later I became part of another newly formed spin-off company, called InCatT (short for Innovative Catalyst Technologies), based on research done at the group of Prof. Joost Reek at UvA. This company commercialised a patented service that finds and optimises catalysts for chemical companies. With our technology we were able to decrease the catalyst development time and thus reduce the

time to market. The start looked promising, but a changing pharma market, take-overs, and mergers, and finally closures of major industrial research facilities in the Netherlands resulted in a difficult initial phase. After five years, we joined the Ace Venture Lab where we redefined the company strategy during the boot camp. We still use the business coach we hooked up to then to keep track of the company developments.”

“Since November 2014, I am the CEO of InCatT. My job consists of an exciting mix of business and research topics, ranging from setting up business deals, exploring markets, leading a group of highly motivated researchers, keeping track of the latest scientific developments and finding new business opportunities. Every day you need to give 100% and be able to quickly adjust to the ever-changing markets. And once a year I am now a coach myself at the Ace Venture Lab boot camp, using my knowledge to help the next generation of entrepreneurs.” Ω

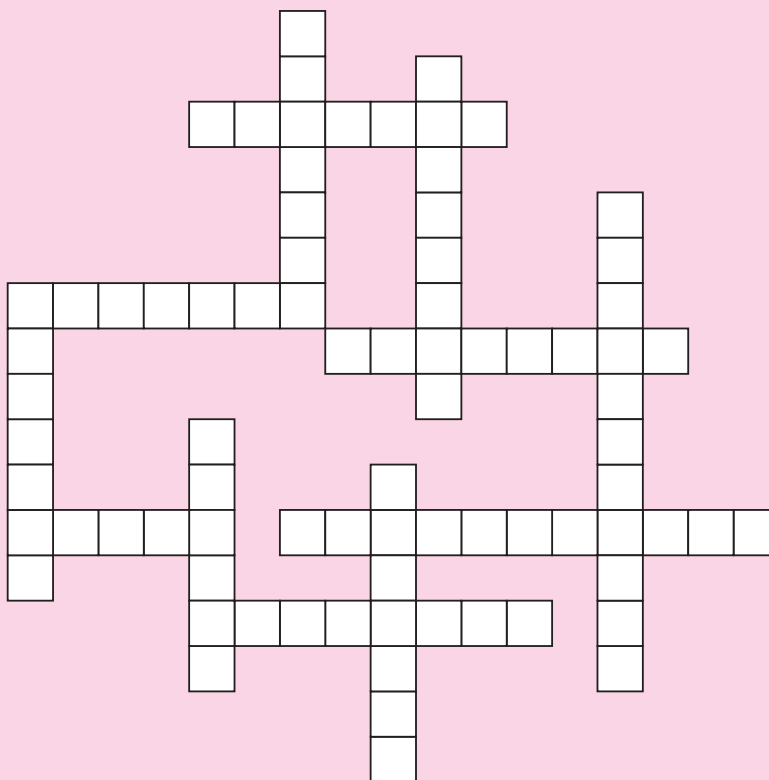
“My job consists of an exciting mix of business and research topics”

→ **Insider’s advice:**

“Develop your business instinct, build a large network, and when a business opportunity arises, go for it!”

puzzle

Like the sentence "This sentence contains eight words and seven spaces", this crossword puzzle will completely describe itself when filled out correctly. Each (horizontal or vertical) section of the puzzle states how often a certain letter is used in the puzzle as a whole, for example: "Five Qs", "Twelve Bs" and "One R". Make sure to use the form [NUMBER WRITTEN AS A WORD][SPACE][LETTER](S) to fill the rows and columns (note: the plural 's' is only added for numbers larger than one). Once completed, the rows and columns should state the number of times each letter is used in the whole puzzle. In the next issue, we will not only reveal the answer but also the creator of this original kind of puzzle.



answer puzzle issue 1

The answer to the puzzle in issue 2 of Amsterdam Science is:



Congratulations to the winners below, who sent the correct answers and won an Amsterdam Science t-shirt:

Marcel Bartels
Melvin Van Den Bout
Maarten Hammer
Gorjan Jovanovski



**before
June 30th 2016**

mail the answer to
amsterdamscience@gmail.com

win
the first ten correct answers will win an
Amsterdam Science T-shirt

cartoon



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Short information about magazine



→ **Amsterdam Science** gives Master's students, PhD students and researchers a platform for communicating their latest and most interesting findings to a broad audience. This is an opportunity to show each other and the rest of the world the enormous creativity, quality, diversity and enthusiasm that characterises the Amsterdam science community.

Amsterdam Science covers all research areas being pursued in Amsterdam: mathematics, chemistry, astronomy, physics, biological and biomedical sciences, health sciences, ecology, earth and environmental sciences, forensic science, computer science, logic and cognitive sciences.

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The editorial board of Amsterdam Science consists of Master's students, PhD researchers and other

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Destructive salt crystals

The image shows the crystallisation of sodium chloride, the most abundant salt on earth, in sandstone. The electron microscope brings into focus the precipitation of so-called hopper crystals inside the pore space of the stone. These crystals form when the entrapped salt solution in the porous network dries. In historic cities such as Amsterdam, salt crystallisation in porous materials is one of the major causes of degradation of our cultural heritage. This issue is a focus of research at UvA's Institute of Physics. Ω

More information on page 5.